(12) UK Patent Application (19) GB (11) 2 082 251 A

(21) Application No 8123955
(22) Date of filing 5 Aug 1981
(30) Priority data
(31) 179325
(32) 18 Aug 1980
(33) United States of America (US)
(43) Application published 3 Mar 1982
(51) INT CL³ F02M 61/04 27/08
(52) Domestic classification F1B 2H 2J15A2 2J15B2 2J15B3 2J15C 2J4A
(56) Documents cited GB 1481707 US 3510112A
(58) Field of search F1B H2A
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(54) Ultrasonic diesel engine fuel injector

(57) The valve 16, opened by fuel supplied to the inlet 40, is ultrasonically vibrated when open by the coil 20 surrounding the magnetostrictive material valve stem 22 or by a piezoelectric element connected to the valve stem. The valve may be of the inwardly opening type, Fig. 2*b* (not shown).

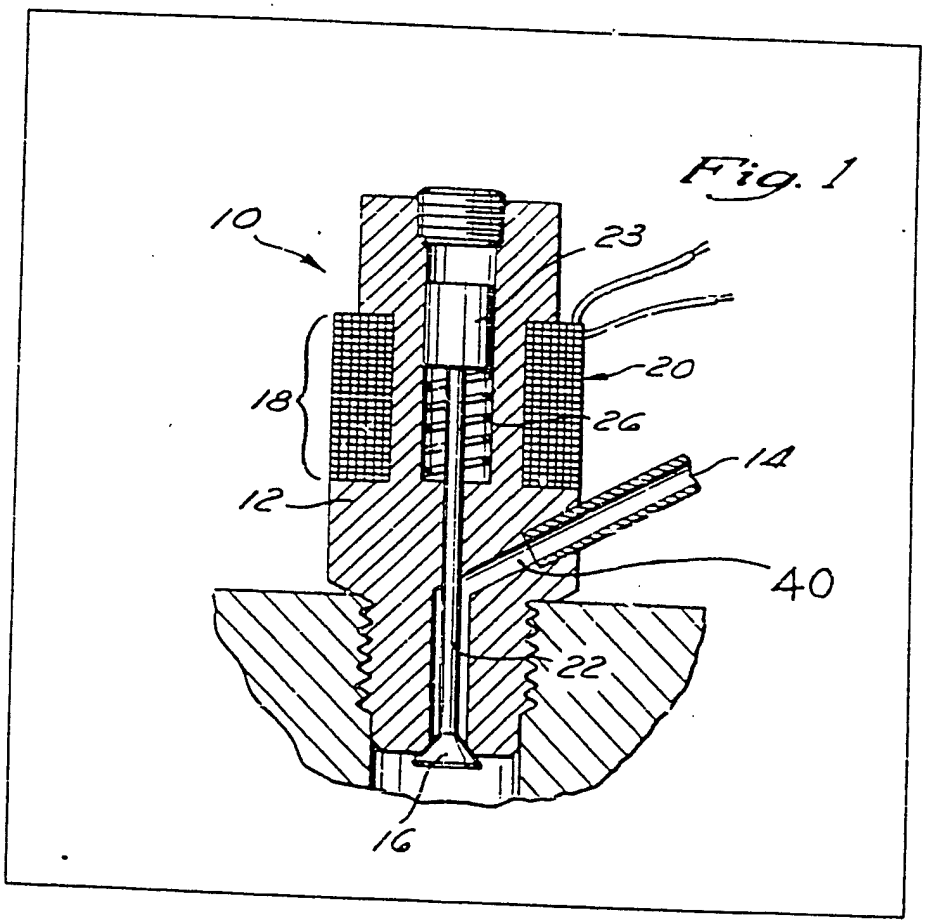

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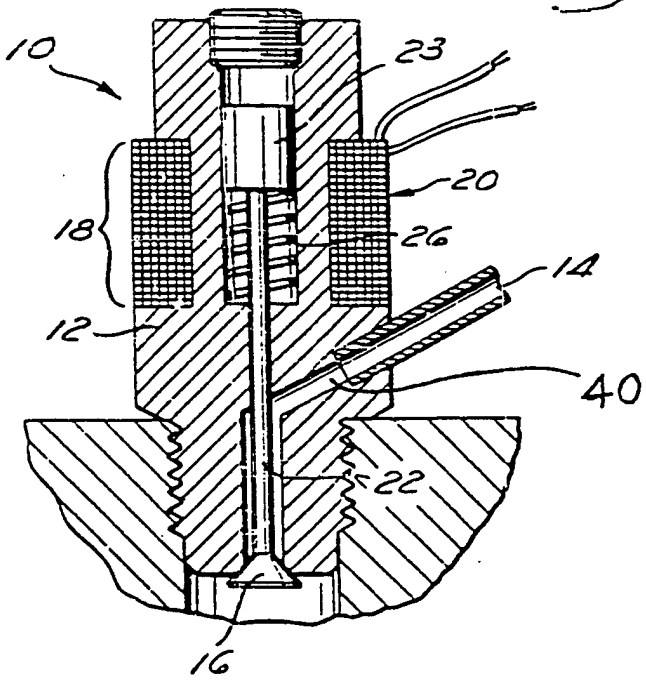
Fig. 1



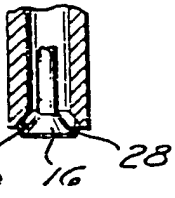


Fig. 2a

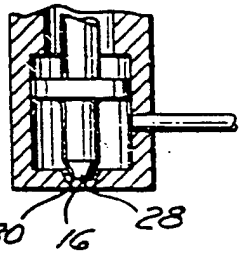


Fig. 2b

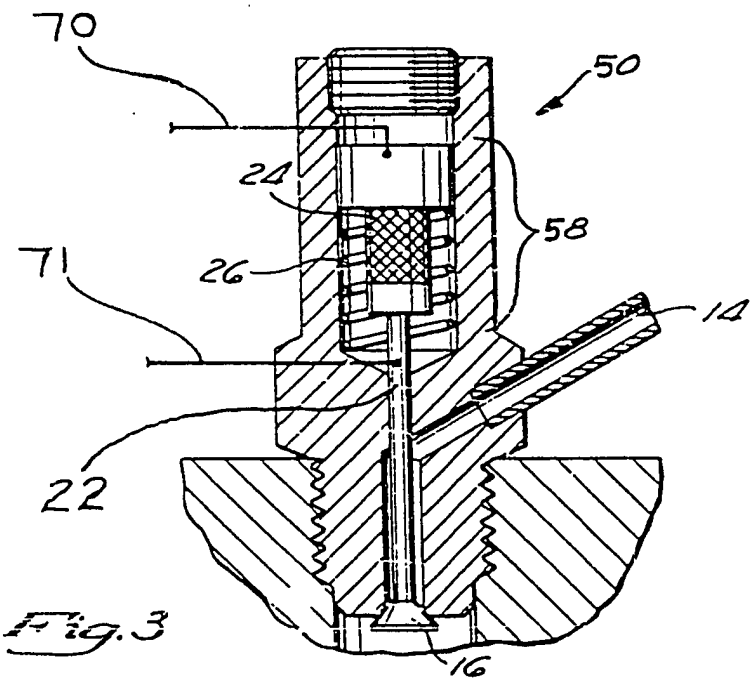


Fig. 3

SPECIFICATION
Ultrasonic diesel fuel injector

The invention relates to diesel fuel injectors for use in diesel engines.

A direct injection or open chamber type diesel engine has an undivided combustion chamber into which diesel fuel is injected when the piston is at or near the end of its compression stroke. In order to penetrate the compressed air present in the chamber and thereby find the oxygen necessary for combustion the fuel is usually injected as a "hard" jet.

However, diesel engines are known having a precombustion chamber communicating with a main combustion chamber in which mixture of the fuel and air is aided by swirling turbulence set up in the precombustion chamber during the compression stroke.

Diesel engines designed according to the precombustion chamber system have the combustion chamber divided into a precombustion chamber, which is incorporated into the cylinder head, and a main combustion chamber which is positioned between the bottom edge of the cylinder head and the head or crown of the piston. The precombustion chamber into which the fuel is injected and in which combustion initially takes place, is connected to the main combustion chamber by means of a narrow slot or flow passage.

In operation, as the piston moves in the direction of the cylinder head air is forced into the precombustion chamber, and near the end of this compression stroke fuel is injected into the precombustion chamber. Subsequently, the combustion products are returned through the flow channel from the precombustion chamber into a secondary combustion chamber formed in the piston head. The combustion of this fuel-air combination generates the thrust necessary to produce the power stroke of the piston.

U.S. Patent No. 4 122 804 describes such an engine with a pencil type fuel injection nozzle having a needle valve movable to shut angularly disposed fuel outlets.

In some precombustion chamber type engines it is advantageous to inject a soft spray of diesel fuel which is more easily mixed, by turbulence, with the swirling gases in the precombustion chamber.

In accordance with the present invention there is provided a diesel engine comprising a fuel injector having a conduit along which diesel fuel can be pumped, a check valve movable between an open position in which diesel fuel is permitted to flow through the conduit and a closed position in which fuel flow is prevented and a means for vibrating the check valve wherein the means for vibrating the check valve can be actuated to reciprocate the check valve at an ultrasonic frequency to atomize passing diesel fuel.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a cross section of an injector having a magneto-strictive-driven check valve.

Fig. 2a is a cross-section of a poppet valve incorporated in the injector.

Fig. 2b is a cross-section of a pintle valve incorporated in the injector.

Fig. 3 is a cross-section of an injector having a piezo-electric-driven check valve.

Figure 1 shows a first ultrasonic diesel fuel injector 10 comprising an injector body 12 which houses a fuel conduit 40 fed at its inlet by a fuel inlet means 14 and having at its outlet a check valve 16. The check valve 16 is rigidly attached to one end of a straight check valve shaft 22 extending through the fuel conduit 40 and is axially slideable between an open position in which fuel is permitted to flow through the fuel conduit 40 and a closed position in which fuel flow is prevented.

The check valve can either be of the poppet type shown in Figure 2a or the pintle type shown in Figure 2b.

A means 18 for inducing high amplitude, high frequency oscillations into the check valve 16 comprises a drive coil 20 disposed about the check valve shaft 22, which shaft 22 is made of a magnetostrictive material. A backing stub 23 made of a non-magnetostrictive material is rigidly attached to the end of the shaft 22 away from the check valve 16 and a spring 26 co-axial with the shaft 22 bears against the backing stub 23 to bias the check valve 16 into the closed position. As described in our copending British Patent Application No. 8105223 (Serial No.), the check valve 16 can be driven at a frequency ranging from about 10 to about 10,000 KHz.

Figure 3 shows a second injector 50 which differs from the first injector 10 only in the means 58 for inducing high amplitude, high frequency oscillations into the check valve 16.

In this embodiment the check valve shaft 22 comprises a piezoelectric element 24 which, in use, has an axial alternating electric field applied to it by means of electrical connections 70 and 71 above and below the piezoelectric element 24.

Although many various modes of operation will provide the desired atomization, the preferred sequence is as follows: fuel flows from the inlet means 14 through the fuel conduit 40 causing the check valve 16 to open against the bias of the spring 26. In the open position, shown in Figs. 2a and 2b, the check valve 16 is displaced from a valve seat 28, by a gap 30, of about two-thousandths of an inch (51×10^{-6} m). Once the check valve 16, is open, the means 18, 58 for inducing the high-amplitude, high-frequency oscillations is activated. After a predetermined amount of fuel has been injected, the means 18, 58 can be turned off and the valve 16 closed.

Although the preferred mode of operation described above discloses a specific sequence of operation and an on/off ultrasonic vibrational mode, it should be noted that neither the specific sequence described nor the specific on/off mode must be followed, since different engines could

require different modes of operation for the injectors 10 and 50.

Obviously many modifications and variations of the present invention are possible in light of the above disclosures. It is therefore to be understood that, within the scope of the appended claims, the invention may be practised otherwise than as specifically described.

CLAIMS

1. A diesel engine comprising a fuel injector having a conduit along which diesel fuel can be pumped, a check valve movable between an open position in which diesel fuel is permitted to flow through the conduit and a closed position in which the fuel flow is prevented and a means for vibrating the check valve wherein the means for vibrating the check valve can be actuated to reciprocate the check valve at an ultrasonic frequency to atomize passing diesel fuel.

2. An engine according to claim 1 wherein the check valve is biased by resilient means into the closed position and opened by diesel fuel pressure in the conduit.

3. An engine according to either of claims 1 or 2 wherein the check valve is a poppet valve.

4. An engine according to either of claims 1 or 2 wherein the check valve is a pintle valve.

5. An engine according to any of claims 1 to 4 wherein the check valve comprises a magnetostrictive material, the means for vibrating the check valve is a magnetostriction driving means and reciprocation if the check valve is by actuation of the magnetostriction driving means to cause alternate lengthening and shortening of the check valve at an ultrasonic frequency.

6. An engine according to any of Claims 1 to 4 wherein the check valve comprises a piezoelectric material and reciprocation of the check valve is by application of an alternating electric field to the piezoelectric material to cause alternate lengthening and shortening of the check valve at an ultrasonic frequency.

7. An engine according to any of claims 1 to 6 wherein the diesel fuel injector is positioned to inject diesel fuel into a precombustion chamber.

8. A diesel engine substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.